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TECHNICAL REPORT ARLCD-TR-78063

BALLISTIC EVALUATION OF M30 PROPELLANT  
CONTAINING NITROGUANIDINE DERIVED FROM  
UREA/AMMONIUM NITRATE PROCESS

M 456A1

J. WENDELL LEACH

DECEMBER 1978



US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND  
LARGE CALIBER  
WEAPON SYSTEMS LABORATORY  
DOVER, NEW JERSEY

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ERRATA

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CONTAINING NITROGUANIDINE DERIVED FROM  
UREA/AMMONIUM NITRATE PROCESS

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The AD-E number on this report was assigned incorrectly. The correct number should be changed to AD-E400 284.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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11. CONTROLLING OFFICE NAME AND ADDRESS Commander, ARRADCOM STINFO, TSD (DRDAR-TSS) Dover, NJ 07801		12. REPORT DATE December 1978
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) <div style="display: flex; justify-content: space-between;"> <div> Propellant M30  Cartridge 105mm, M456A1  Nitroguanidine  Guanidine nitrate  Urea/ammonium nitrate (U/AN) process </div> <div> British aqueous fusion (BAF) process  Closed bomb tests  Arc-image furnace  Ballistic tests </div> </div>		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p>This study was conducted to determine if nitroguanidine converted from guanidine nitrate produced by the urea/ammonium nitrate (U/AN) process would meet military specifications and would be ballistically acceptable in M30 triple-base propellants.</p> <p>M30 triple-base propellant lots were manufactured utilizing nitroguanidine prepared from guanidine nitrate produced by the urea/ammonium nitrate (U/AN) process.</p>		

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Ballistic and other test results indicated there was no significant difference between M30 propellant containing U/AN prepared nitroguanidine and the standard British aqueous fusion (BAF) process nitroguanidine.

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#### ACKNOWLEDGEMENTS

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Mr. Elry Hayes of the Energetic Materials Division, LCWSL, ARRADCOM, Dover, NJ

Mr. Clifford D. Murphy of the Jefferson Proving Ground, Madison, IN.

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## SUMMARY

M30 propellant lots were manufactured that contained nitroguanidine prepared from guanidine nitrate produced by the urea/ammonium nitrate process. The guanidine nitrate was produced at pilot facilities located at Hercules, Inc., Kenvil, NJ. The guanidine nitrate was converted to nitroguanidine at the Welland Plant, Cyanamid of Canada, Ltd. The nitroguanidine was used to prepare M30 propellant lots at ARRADCOM which were subsequently ballistically fired at the Jefferson Proving Ground. Ballistic and other test results indicated there were no significant differences between M30 propellants containing urea/ammonium nitrate process derived nitroguanidine and those containing standard British aqueous fusion process nitroguanidine.

## INTRODUCTION

This project was accomplished as part of the U.S. Army Manufacturing Technology Program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in the production of Army materiel.

In 1968, the U.S. Army was notified by North American Cyanamid Ltd that manufacture of nitroguanidine would be discontinued. Consequently, to meet future requirements, studies were initiated to evaluate new methods of manufacture and to obtain data on plant design. As a result of the studies, the already piloted British aqueous fusion (BAF) process engineering was updated. Although the urea/ammonium nitrate (U/AN) process was recommended as the preferred method primarily because of its simplicity, improved product quality, capital costs, and the availability of materials (ref. 1), the urgency of maintaining a source of supply dictated the selection of the more technically developed BAF process.

This report is a supplement to PATR 4566 (ref. 1). It covers additional technical and engineering efforts to provide data involving the ballistic evaluation of M30 propellant which contained nitroguanidine that was converted at the Welland Plant, Cyanamid of Canada, Ltd from guanidine nitrate produced by U/AN process.

## DISCUSSION

A total of 9102 kg (20,067 lb) of guanidine nitrate produced by the U/AN pilot plant at Hercules Inc. of Kenvil, NJ, was shipped to the Welland Plant, Cyanamid of Canada, Ltd and converted to nitroguanidine using the standard process of the Welland Plant. No difficulties were encountered in processing and the product met specification requirements (fig. 1).

Using standard manufacturing procedures and operating conditions, as described in the Picatinny Arsenal Description of Manufacture 35-3-123, four lots of M30 propellant were manufactured without difficulty at Picatinny Arsenal. A Propellant Description Sheet (figs. 2-5) was completed for each lot. The lots met all the chemical and physical requirements of the applicable specifications. The M30 propellant manufactured from the U/AN process material consisted of three lots of different web sizes and one control lot in which standard nitroguanidine was used.

The lot designations and descriptions are as follows:

PA-E 03623 - 1.29 mm web - U/AN process nitroguanidine

PA-E 03624 - 1.35 mm web - U/AN process nitroguanidine

PA-E 03625 - 1.40 mm web - U/AN process nitroguanidine

PA-E 03626 - 1.36 mm web - Standard process nitroguanidine  
(control).

Closed bomb tests were evaluated for the three U/AN propellant lots and the standard process lot and were compared to the standard propellant lot RAD 63574 used in cartridge M456A1, 105 mm, HEAT-T. Tests were conducted at a loading density of 0.2 gm/cc at 32°C and -40°C (table 1).

Note, Lot RAD 63574 is an M30 calibration propellant produced at Radford Arsenal, VA, and is the standard calibration lot used at the Jefferson Proving Ground (JPG). This material has been tested extensively, is a known quantity, and has been satisfactorily tested in large quantities. The closed bomb tests showed satisfactory behavior of the test lots.

Relative ignitability tests were conducted on the propellant compositions that were produced with U/AN process nitroguanidine. The testing was conducted in an "Arc-Image Furnace." Ignition is achieved by reimagining projected radiation through the use of ellipsoidal mirrors. The radiant energy reaches the sample in predetermined, timed impulses through the use of a light "chopper" in the system. The operation of the arc-image apparatus is described in reference 2. The test data (table 2) indicates the U/AN process nitroguanidine is slightly more difficult to ignite than the standard material; however, the difference in ignitability is considered minor.

Ballistic firings of the M30 propellant lots were conducted at Jefferson Proving Ground and the data is reported in Test Report 74-2638 (ref. 3). Cartridge 105 mm HEAT-T, M456A1 was used in the ballistic tests. All M456A1 rounds were assembled in accordance with PA Dwg. NO. 886195 with the following exceptions:

1. The primers were not staked.
2. The cases were crimped with eight, equally-spaced tab crimps.

A charge assessment was performed using each of the four pilot lots and 10 calibration rounds. In addition, 10 rounds from each lot at the assessed charge weight were fired at 21°C. This procedure was repeated using two lots (PA-E 03624 and PA-E 03625) with the optimum web size, and the control lot (PA-E-03626) at 46 and 63°C. The firing sequence is shown in table 3. The control lot and the two test lots contained lower charge weights than the calibration lot as shown in table 4. Lot PA-E 03623 was not tested at -45.5°C (-50°F) and 62.8°C (145°F) because with a web size of 1.27 mm (0.05 in.), it was considered to burn too fast at the higher temperature which might have resulted in excessive combustion pressures that could have damaged the gun.

As shown in table 4, lots PA-E 03624 and PA-E 03625 compare favorably in velocity, pressure, and ignition delay times with the control lot (PA-E 03626) and the calibration lot (RAD 63574).

The test data shows that the U/AN process derived nitroguanidine propellants meet the ballistic requirements for the M456A1 HEAT cartridge; and, that the lot with the web most closely matching the control lot web is also a close match for the ballistic level. Velocity and pressure data values at temperature extremes are satisfactory and show approximately the same temperature coefficients (table 5). It was observed during loading that the assembly time was less than expected and also that an ease of loading prevailed. The shorter assembly time did not appear to be related to bulk density but could be related either to the graphite glaze on the newer propellant being slicker or to the lower charge weights.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

1. The conversion of guanidine nitrate, manufactured by the U/AN process, to nitroguanidine presented no manufacturing problems. The nitroguanidine met all applicable specifications.
2. The M30 propellant prepared with nitroguanidine, converted from the U/AN process derived guanidine nitrate, was found to be ballistically equivalent to M30 propellant made with BAF process derived nitroguanidine.
3. Ignitability tests showed no significant difference in the ignitability characteristics of M30 propellants prepared with nitroguanidine derived from either the U/AN or the BAF processes (ref.4).

4. No product performance difficulties are anticipated in the event that the U/AN process is selected for future facilities plant construction.

#### Recommendations

It is recommended that no further studies be conducted with U/AN process derived nitroguanidine.

#### REFERENCES

1. C.H. Nichols, PATR 4566, "Evaluation of Technologies to Produce Nitroguanidine," Picatinny Arsenal, Dover, NJ, Oct 1973.
2. E. Hayes, "Ballistics and Combustion Research Branch Report No. 75-FR-G-B-6," Picatinny Arsenal, Dover, NJ, Apr 1975.
3. Clifford D. Murphy, Test Report No. 74-2638, "Engineer Design Test of Propellant M-30 for Cartridge 105 mm, HEAT-T; M456A1 (Nitroguanidine)," Jefferson Proving Ground, IN, Dec 1974.
4. G.R. Kazin, Final Report MM&TE Project 5744169, "M-30 Propellant Manufactured with Nitroguanidine from the Urea Ammonium Nitrate Process Formulation and Ballistic Evaluation," Picatinny Arsenal, Dover, NJ, Nov 1975.

Table 1. Closed bomb test results

<u>STANDARD</u>	<u>TEST PROPELLANT</u>	TEST ° F	RELATIVE QUICKNESS % at Pressures, psi				PSI AVG	RELATIVE FORCE %
			10,000 (69 MPa)	15,000 (103 MPa)	20,000 (138 MPa)	26,000 (181 MPa)		
RAD63574		90 (32°C)	100.0	100.0	100.0			100.0
	PAE03623	90 (32°C)	108.9	106.8	107.3		107.7 (743kPa)	99.5
	PAE03624	90 (32°C)	101.5	103.3	104.9		103.2 (712kPa)	100.1
	PAE03625	90 (32°C)	105.5	102.5	101.4		103.1 (711kPa)	100.4
	PAE 03626	90 (32°C)	100.0	101.8	102.8		101.5 (700kPa)	99.8
RAD63574		-40 (-40°C)	100.0	100.0	100.0			100.0
	PAE 03623	-40 (-40°C)	104.3	107.8	108.8		107.0 (738kPa)	100.0
	PAE 03624	-40 (-40°C)	101.2	101.0	103.8		102.0 (703kPa)	100.2
	PAE 03625	-40 (-40°C)	96.5	100.7	101.8		99.7 (687kPa)	100.2
	PAE 03626	-40 (-40°C)	95.8	99.3	101.8		99.0 (683kPa)	99.1

Table 2. Radiant energy ignition of M30 propellants

$$P_o = .7 \text{ MPa, } N_2$$

$$= 100 \text{ psi } N_2$$

$$Q = 100 \text{ cal cm}^{-2} \text{ sec}^{-1}$$

GRAPHITE GLAZED (As Received)

SAMPLE LOT NO.	LATERAL SECTION		END SECTION		
	* 50%		50%		
	Q $\pm$ Std dev	95% Q	Q $\pm$ Std dev	95% Q	
PAE-03623	2.06 $\pm$ .21	2.41	2.06 $\pm$ .21	2.41	
PAE-03624	1.81 $\pm$ .11	2.00	2.25 $\pm$ .25	2.67	
PAE-03625	1.88 $\pm$ .18	2.16	2.06 $\pm$ .21	2.41	
PAE-03626 (Control)	1.65 $\pm$ .15	1.90	1.88 $\pm$ .18	2.16	

LEGEND:

Po = pressure in sample chamber

Q = energy per unit area per unit time (cal/cm<sup>2</sup> sec)

\*Percentages = frequency of initiation at the specified Q level

Table 3. Firing Sequence

<u>Date</u>	<u>Lot no.</u>	<u>No. rds</u>	<u>Phase</u>	<u>Temp</u>
25 Jul 74	PA-E-03623	9	Chg assess	+70°F (21°C)
"	PA-E-03624	9	"	"
"	PA-E-03625	9	"	"
"	PA-E-03626	9	"	"
9 Aug 74	PA-E-03623	10	Uniformity	+70°F (21°C)
"	PA-E-03624	10	"	"
"	PA-E-03625	10	"	"
"	PA-E-03626	10	"	"
2 Oct 74	PA-E-03626	10	Uniformity	-50°F (-46°C)
"	(control lot)			
"	PA-E-03624	10	"	"
"	PA-E-03625	10	"	"
3,4 Oct 74	PA-E-03626	10	Uniformity	+145°F (63°C)
"	(control lot)			
"	PA-E-03624	10	"	"
"	PA-E-03625	10	"	"



Table 4. Extract from JPG rpt 74-2638  
M30 propellant for 105 mm HEAT-T, M456A1

PROP LOT	RAD 63574			PA-E 03626		PA-E 03624		PA-E 03625	
	CALIBRATION			CONTROL		U/AN		U/AN	
WEB/CHG.WT.	1.32MM/5.13 kg .052"/183.2 oz			1.36MM/5.02 kg .0535"/179.2 oz		1.35MM/5.03 kg .0533"/179.7 oz		1.40MM/5.06 kg .0551"/180.8 oz	
VELOCITY									
TEMP.		AVG	STD DEV	AVC	STD DEV	AVC	STD DEV	AVG	STD DEV
145°F	F/S	---	---	3989	6.9	3992	13.0	3987	6.1
63°C	m/s	---	---	1216	2.1	1217	4.0	1215	1.9
70°F	F/S	3803	9.6	3831	6.3	3839	10.0	3829	6.9
21°C	m/s	1184	2.9	1168	1.9	1170	3.1	1167	2.1
-50°F	F/S	----	---	3723	8.2	3711	9.2	3707	9.7
-46°C	m/s	----	---	1135	2.5	1131	2.8	1130	5.9
PRESSURE									
145°F	psi/100	---	---	735	9.6	724	9.8	703	11.3
63°C	MPa	---	---	507	6.6	499	6.8	485	7.8
70°F	psi/100	618	5.0	601	5.8	604	5.5	598	5.6
21°C	MPa	426	3.4	414	4.0	416	3.8	412	3.9
-50°F	psi/100	---	---	525	7.5	514	14.7	516	14.7
-46°C		---	---	362	5.2	354	10.1	356	10.1
IGNITION DELAY - MILSEC									
145°F (63°C)	113	13.0		69	8.0	69	14.0	72	7.0
70°F (21°C)				82	8.0	76	11.0	77	10.0
-50°F (-46°C)				146	11.0	163	19.0	150	14.0

Table 5. Temperature coefficients - velocity and pressure

<u>LOT NO.</u>	<u>VELOCITY</u>		<u>PRESSURE</u>	
	f/s °F	m/sec °C	psi/°F	MPa/°C
PA-E 03624	1.44	.79	108	1.34
PA-E 03625	1.44	.79	96	1.19
PA-E 03626	1.36	.75	108	1.34

Temp. Coeff. =  $\Delta V / \Delta T$

$$\text{Example: } \frac{\Delta V}{\Delta T} = \frac{3992 \text{ fps} - 3711 \text{ fps}}{145^{\circ}\text{F} - (-50^{\circ}\text{F})} = \frac{281 \text{ fps}}{195^{\circ}\text{F}} = 1.44 \text{ fps}/^{\circ}\text{F}$$

Conversion to Metric

$$\frac{1.44 \text{ ft}}{\text{sec } ^{\circ}\text{F}} \times \frac{.3048 \text{ m}}{\text{ft}} \times \frac{1.8^{\circ}\text{F}}{^{\circ}\text{C}} = \frac{.79 \text{ m}}{\text{sec } ^{\circ}\text{C}}$$

$$\frac{\Delta P}{\Delta T} = \frac{73500 \text{ psi} - 52500 \text{ psi}}{145^{\circ}\text{F} - (-50^{\circ}\text{F})} = \frac{21,000 \text{ psi}}{195^{\circ}\text{F}} = \frac{108 \text{ psi}}{^{\circ}\text{F}}$$

Conversion to Metric

$$\frac{108 \text{ psi}}{^{\circ}\text{F}} \times \frac{6895 \text{ Pa}}{\text{psi}} \times \frac{1.8^{\circ}\text{F}}{^{\circ}\text{C}} \times \frac{\text{MPa}}{10^6 \text{ Pa}} = \frac{1.34 \text{ MPa}}{^{\circ}\text{C}}$$



110 0589

CYANAMID OF CANADA  
WELLAND PLANT

CONTROL DEPARTMENT

240 M 01173

NITROGUANIDINE SHIPMENT ANALYSIS

COPIES TO:

1-6	REAR	CANADIAN
7	HEAD	
8	HEAD	OTTAWA
9	ADSA SAJAP REP.	
10	ADSA SAJAP REP.	
11	ADPT. NITROGUANIDINE	
12	TECHNICAL FILE	

SPECIFICATION EOPA - 45940-8  
MIL N 402A

CUSTOMER PICATUNNY ARSENAL

CAR NO WHITTEN TRANSPORT

LOTS FROM U/AN 1 THROUGH U/AN 1

ANALYTICAL RESULTS		LOT NO. U/AN 1 1-100	LOT NO. U/AN 2 1-88	LOT NO.	LOT NO.
TEST	LIMIT				
AV. PARTICLE DIAMETER	6.0 MICRONS MAX. 3.4 MICRONS MIN.	5.0	5.1		
PURITY	99.0% MIN.	99.8	99.8		
ASH CONTENT	0.30% MAX.	0.06	0.05		
PH VALUE	4.5 MIN. 7.0 MAX.	5.5	5.8		
ACIDITY (H <sub>2</sub> SO <sub>4</sub> )	0.06% MAX.	0.01	0.01		
TOTAL VOLATILE	0.25% MAX.	0.08	0.04		
SULFATE (NA <sub>2</sub> SO <sub>4</sub> )	0.20% MAX.	0.06	0.03		
WATER INSOLUBLE	0.20% MAX.	0.03	0.05		

CERTIFIED THAT SAMPLING AND TESTING OF THE ABOVE DEFINED MATERIAL WAS CONDUCTED IN ACCORDANCE WITH THE "QUALITY ASSURANCE PLAN FOR NITROGUANIDINE" AND THAT THE RECORD OF ALL ANALYSES ARE ON FILE AT THE WELLAND PLANT OF CYANAMID OF CANADA LIMITED.

*Rolene Gill*  
LABORATORY SUPERVISOR

Figure 1. Nitroguanidine analysis results.

# PROPELLANT DESCRIPTION SHEET

US ARMY LOT NO. <u>PA-E-03623</u>		OF 18 <u>74</u>		COMPOSITION NO. <u>Propellant M30 for Cartridge</u>		
105 MM Heat-T, M456A1						
MANUFACTURED AT <u>Picatinny Arsenal, Dover, N. J.</u>		PACKED AMOUNT <u>952 lbs.</u>				
CONTRACT NO. <u>*5573-06</u>		DATE <u>15 Oct. 73</u>		SPECIFICATION NO. <u>Mil-P-46158D, 2 Feb. 68</u>		
*AMCMS: <u>4932.05.4169</u>		Mil-STD-652B, 19 Sept. 69				
NITROCELLULOSE						
ACCEPTED BLEND NUMBERS						
HLP-221/L, Grade A, Type 1			NITROGEN CONTENT -		KI STARCH (65.5°C)	
			MAX <u>12.70</u> %	MINS	STABILITY (1134.5°C)	
			MIN <u>12.50</u> %	MINS	30 MINS	
			AVG <u>12.53</u> %	MINS	30 MINS	
					EXPLOSION MINS	
0.20 POUNDS SOLVENT PER POUND NO/DRY WEIGHT INGREDIENTS CONSISTING OF 60 POUNDS ALCOHOL AND 40 POUNDS Acetone PER 100 POUNDS SOLVENT						
PERCENTAGE REMIX TO WHOLE <u>None</u>						
TEMPERATURES		PROCESS-SOLVENT RECOVERY AND DRYING			TIME	
FROM	TO				DATE	
20°C	50°C	Room Temperature			15	
	50°C	Temperature Raised 2°C per hr.				
	50°C	Dry House, Air Dry - Constant Temperature			3	
TESTS OF FINISHED PROPELLANT						
PROPELLANT COMPOSITION			STABILITY AND PHYSICAL TESTS			
CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED	HEAT TEST	FORMULA	
Nitrocellulose	28.00	± 1.30	27.94	HEAT TEST 120°C	40 min	
Nitroglycerin	22.50	± 1.00	22.66	Explosion	300+	
Nitroguanidine	47.70	± 1.00	47.60	FORM OF PROPELLANT	Gr 15	
Ethyl Centralite	1.50	± 0.10	1.49	No. of perforations	7	
Gryolite	0.30	± 0.10	0.31	Specific Gravity @ 15.5°C	1.68	
				No. of Grains/lb	401.3	
Total Volatiles	0.50	Max	0.14	Grav. Density or lbs/cu ft.	55.6	
Graphite (Glazed)	0.15	Max	0.11			
** U/AN2						
CLOSED BOMB			PROPELLANT DIMENSIONS (INCHES)			
TEST	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE	MEAN VARIATION IN % OF MEAN DIMENSIONS	
	PA-E-03623	90	107.7	99.5	SPEC	ACTUAL
	PA-E-03623	-40	106.9	100.0	LENGTH (L)	0.6621 0.6711 6.25 Max 0.95
					DIAMETER (DI)	0.3200 0.2933 1.25 Max 0.92
STANDARD	RAD-63574	90	100.00%	100.00%	PERF DIA (DI)	0.0330 0.0301 DATES
REMARKS	RAD-63574	-40	100.00%	100.00%	0.0540 0.0503	
					0.0565 0.0508	PACKED April 74
					0.0553 0.0506	SAMPLED Apr. 74
					0.0505	TEST FINISHED 4-15-74
All standard and test Propellants were fired at a loading density of 0.2 gm/cc.					The values for R.Q. are based on an average of the figures obtained at the varied pressure points.	
					WEB DIFFERENCE (STD DEV IN % OF WEB AVERAGE)	15% Max.
					L-D	2.10 to 2.50
					B-D	5.0 to 19
						2.29
						9.65
					DESCRIPTION SHEETS FORWARDED	
TYPE OF PACKING CONTAINER <u>Box, Steel M2, Dwg. 76-4-53, 15 Aug. 1945.</u>						
REMARKS <u>This lot does meet all the chemical and physical requirements of the applicable specifications</u>						
CONTRACTOR'S REPRESENTATIVE <u>J.R. MARSCOVETE, CH, Props &amp; Expls Div, IOD</u>				GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE <u>E.E. Morris</u>		

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Figure 2. Description of lot no. PA-E-03623.





## PROPELLANT DESCRIPTION SHEET.

US ARMY LOT NO. <b>PA-E-03625</b>		OF 19 <b>74</b>		COMPOSITION NO. <b>Propellant M30 for Cartridge</b>	
105 M Heat-T, M456A1					
MANUFACTURED AT <b>Picatinny Arsenal, Dover, N. J.</b>		PACKED AMOUNT <b>982 lbs.</b>			
CONTRACT NO. <b>W5573-06</b>		DATE <b>15 Oct. 73</b>		SPECIFICATION NO. <b>MIL-P-16158D, 2 Feb 68</b>	
<b>*AMCMS:4932.05.4169</b>		<b>MIL-STD-652B, 19 Sept. 69</b>			

NITROCELLULOSE			
ACCEPTED BLEND NUMBERS			
<b>HLP-221/L, Grade A, Type 1</b>			
		NITROGEN CONTENT	KI STARCH(86.5%)
	MAX <b>12.70</b> %	MINS	MINS
	MIN <b>12.50</b> %	MINS	<b>30</b> MINS
	AVG <b>12.53</b> %	MINS	<b>30</b> MINS
		EXPLOSION MINS	

<b>0.20</b>	MANUFACTURE OF PROPELLANT	
POUNDS SOLVENT PER POUND NO/DRY WEIGHT INGREDIENTS CONSISTING OF <b>50</b> POUNDS ALCOHOL AND <b>1.0</b> POUNDS <b>Acetone</b> PER <b>100</b> PC <b>106</b> SOLVENT		
PERCENTAGE REMIX TO WHOLE <b>None</b>		

TEMPERATURES		PROCESS-SOLVENT RECOVERY AND DRYING		TIME	
FROM	TO			DAYS	HOURS
<b>20°C</b>	<b>20°C</b>	<b>Room Temperature</b>			<b>24</b>
<b>20°C</b>	<b>50°C</b>	<b>Temperature Raised 2°C per hr.</b>			<b>15</b>
	<b>50°C</b>	<b>Dry House, Air Dry - Constant Temperature</b>		<b>3</b>	

TESTS OF FINISHED PROPELLANT				STABILITY AND PHYSICAL TESTS		
CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED		FORMULA	ACTUAL
<b>Nitrocellulose</b>	<b>28.00</b>	<b>± 1.30</b>	<b>27.64</b>	<b>HEAT TEST 120°C</b>	<b>40 Min</b>	<b>90</b>
<b>Nitroglycerin</b>	<b>22.50</b>	<b>± 1.00</b>	<b>22.63</b>	<b>Explosion</b>		<b>300+</b>
<b>Nitroguanidine</b>	<b>47.70</b>	<b>± 1.00</b>	<b>47.93</b>	<b>FORM OF PROPELLANT</b>		<b>3rd</b>
<b>Ethyl Centralite</b>	<b>1.50</b>	<b>± 0.10</b>	<b>1.50</b>	<b>No. of perforations</b>		<b>7</b>
<b>Cryolite</b>	<b>0.30</b>	<b>± 0.10</b>	<b>0.30</b>	<b>Specific Gravity @ 25.0°C</b>		<b>1.08</b>
				<b>No. of Grains/lb</b>		<b>319.8</b>
<b>Total Volatiles</b>	<b>0.50</b>	<b>Max</b>	<b>0.15</b>	<b>Grav. Density of lbs/cu ft</b>		<b>55.1</b>
<b>Graphite</b>	<b>0.15</b>	<b>Max</b>	<b>0.14</b>			
<b>U/AN 2</b>						

CLOSED BOMB				PROPELLANT DIMENSIONS (INCHES)			
TEST	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE	SPEC	DIE	FINISHED
	<b>PA-E-03625</b>	<b>90</b>	<b>103.1</b>	<b>100.4</b>		<b>0.7295</b>	<b>0.7337</b>
	<b>PA-E-03625</b>	<b>-40</b>	<b>99.7</b>	<b>100.2</b>	<b>LENGTH (L)</b>		<b>6.25</b>
					<b>DIA</b>	<b>0.3500</b>	<b>0.3167</b>
STANDARD	<b>RAD-63574</b>	<b>90</b>	<b>100.00%</b>	<b>100.00%</b>	<b>PERF DIA (d)</b>	<b>0.0360</b>	<b>0.0322</b>
REMARKS	<b>RAD-63574</b>	<b>-40</b>	<b>100.00%</b>	<b>100.00%</b>	<b>Wt</b>	<b>0.0595</b>	<b>0.0538</b>
					<b>Wt</b>	<b>0.0615</b>	<b>0.0563</b>
					<b>Wt</b>	<b>0.0605</b>	<b>0.0551</b>
					<b>Wt</b>	<b>0.0550</b>	
<b>GM/cc.</b>					<b>WEB DIFFERENCE</b>	<b>15% Max.</b>	<b>4.54</b>
					<b>% DEV IN % OF WEB AVERAGE</b>		<b>2.32</b>
					<b>L/D</b>	<b>2.10 to 2.50</b>	<b>2.32</b>
					<b>Od</b>	<b>5.0 to 19</b>	<b>9.84</b>

All standard and test propellants were fired at a loading density of 0.2 The values for R.Q. are based on an average of the figures obtained at the varied pressure points.		Packed <b>4 Apr. 74</b> Sampled <b>4 Apr. 74</b> Test finished <b>4-15-74</b> Offered <b>20 Apr. 74</b> Description sheets forwarded <b>2 May 1974</b>
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TYPE OF PACKING CONTAINER <b>Box, Steel M2, Dwg. 76-4-53, 15 Aug. 1945.</b> REMARKS <b>This lot does meet all the chemical and physical requirements of the applicable specifications</b>	
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CONTRACTOR'S REPRESENTATIVE <b>J.R.MARSICOVETE, Ch, Props &amp; Expls Div, IOD</b>	GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE <b>E.E. Harris</b>
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Figure 4. Description of lot no. PA-E-03625.

# PROPELLANT DESCRIPTION SHEET

US ARMY LOT NO. <u>PA-E-03626</u> OF <u>18</u> 74		COMPOSITION NO. <u>Propellant M30 for Cartridge</u>	
105 MM Heat-T, M450A1			
MANUFACTURED AT <u>Picatinny Arsenal, Dover, N. J.</u>		PACKED AMOUNT <u>970 lbs</u>	
CONTRACT NO. <u>5573-06</u> DATE <u>15 Oct. 73</u>		SPECIFICATION NO. <u>Mil-P-16158n, 2 Feb 68</u>	
*AMCMS: 4932.05.4169		Mil-STD-652B, 19 Sept. 69	
NITROCELLULOSE			
ACCEPTED BLEND NUMBERS			
<u>HMP-221/L, Grade A, Type 1</u>			
		NITROGEN CONTENT	KI STARCH(65.5°C)
		MAX <u>12.70</u> %	MINS
		MIN <u>12.50</u> %	MINS
		AVG <u>12.53</u> %	MINS
			EXPLOSION MINS
0.20 POUNDS SOLVENT PER POUND NO DRY WEIGHT INGREDIENTS CONSISTING OF <u>60</u> POUNDS ALCOHOL AND <u>40</u> POUNDS Acetone PER 100 POUNDS SOLVENT			
PERCENTAGE REMIX TO WHOLE <u>None</u>			
PROCESS-SOLVENT RECOVERY AND DRYING			
TEMPERATURES		TIME	
FROM	TO	DAYS	HOURS
20°C	20°C		24
20°C	50°C		15
	50°C	3	
Dry House, Air Dry - Constant Temperature			
TESTS OF FINISHED PROPELLANT			
PROPELLANT COMPOSITION		STABILITY AND PHYSICAL TESTS	
CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED
Nitrocellulose	28.00	± 1.30	27.56
Nitroglycerin	22.50	± 1.00	22.69
Nitroguanidine	47.70	± 1.00	47.93
Ethyl Centralite	1.50	± 0.10	1.52
Cryolite	0.30	± 0.10	0.30
Total Volatiles	0.50	Max	0.18
Graphite	0.15	Max	0.13
Regular			
		HEAT TEST 120°C 40 Min 93	
		Explosion 300+	
		FORM OF PROPELLANT Cyl	
		No. of perforations 7	
		Specific Gravity @ 15.5°C 1.70	
		No. of Grains/lb 344.4	
		Grav. Density of lbs/Cu ft 55.1	
CLOSED BOMB			
TEST	LOT NUMBER	TEMP °C	RELATIVE QUICKNESS
	PA-E-03626	90	101.5
	PA-E-03626	-40	98.9
STANDARD	RAD-63574	90	100.00%
REMARKS	RAD-63574	-40	100.00%
All standard and test Propellants were fired at a loading density of 0.2 gm/cc.			
The values for R.Q. are based on an average of the figures obtained at the varied pressure points.			
PROPELLANT DIMENSIONS (INCHES)			
	SPEC	DIE	FINISHED
LENGTH (L)		0.7023	0.7200
DIAMETER (D)		0.3300	0.3060
PERF DIA (d)		0.0350	0.0308
W <sub>i</sub>		0.0575	0.0518
W <sub>a</sub>		0.0590	0.0551
W <sub>g</sub>		0.0583	0.0535
WEB DIFFERENCE (STO DEV IN % OF WEB AVERAGE)	15% Max.		6.17
L <sub>10</sub>	2.10 to 2.50		2.35
D <sub>10</sub>	5.0 to 19		9.94
MEAN VARIATION IN % OF MEAN DIMENSIONS			
	SPEC	ACTUAL	
	6.25	6.62	
DATES			
PACKED 11 Apr. 71			
SAMPLED 11 Apr. 71			
TEST FINISH 15 Apr. 71			
OFFERED 26 Apr. 71			
DESCRIPTION SHEETS FORWARDED 2 May 1974			
TYPE OF PACKING CONTAINER <u>Box, Steel M2, Dwg. 76-4-53, 15 Aug. 1945.</u>			
REMARKS <u>This lot does meet all the chemical and physical requirements of the applicable specifications</u>			
CONTRACTOR'S REPRESENTATIVE		GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE	
J.R.MARSICOVETE, Ch, Props & Expls Div, IOD		F.E. Morris	

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Figure 5. Description of lot no. PA-E-03626.





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